Calculators allowed. No other aids permitted.   Maximum 3 hours
Answer all questions on the exam sheets.

(10) 1)   Define the following terms. Use sketches, equations and circuit diagrams as necessary. You must describe what each term is or means. Simply indicating how a term may be calculated, as an example, will not be sufficient to receive full marks.

a)   over compound generator

b)   armature reaction

c)   synchronous motor

d)   locked rotor

e)   transformer

(2)   2)   How do manufacturers design induction motors so that they can be connected to run at either of two distinct voltages?

(2)   3)   Why is it necessary to have overcurrent protection in addition to the 15-A circuit breaker for an induction motor rated at ¾ HP, 230 V, 5.5 A, 60 Hz, 1 phase, 1725 RPM?

(2)   4)   List two benefits of having an inverter (variable frequency drive) controlling a three phase induction motor?

(2)   6)   How would you reverse the direction of rotation for a single phase capacitor-start induction-run motor?

(2)   7)   How many switches and of what type would be required to control an incandescent safety light from four locations?

(2)   8)   Compare and contrast the level of protection offered by a thermal breaker and a thermal breaker with a ground-fault circuit interrupter.

(2)   9)   A three phase induction motor on a conveyor belt is rated at 25 HP, 460 V, 34 A, 1740 RPM, Power Factor of 0.95, and Efficiency of 90%. In a routine check of the motor you measure a source voltage of 455 V and a source current of 28 A. Verbally describe how the other ratings (speed, output power, power factor and efficiency) may be different.

(3)   10)   Your Christmas light display causes a 15-A SPST breaker to trip. Your roommate suggests replacing it with a 30 A SPST breaker. Explain your response.

(3)   11)   How does the magnetic starter coil in the lab rated for 115 VAC provide low voltage protection to the motor?

(10) 12)   Each pole of a 100-kW, 250-V flat compound DC generator has a shunt field of 1900 turns and a series field of 10 turns. If the total shunt-field resistance, the armature resistance and series field resistance is 100 Ω, 0.2 Ω and 0.1 Ω, respectively, what is the voltage generated at the armature under full load conditions?

(4)   13)   An inverter is used to supply electrical energy to a 4-pole single-phase motor at a frequency of 43 Hz. If the rotor slip is 4%, what is the rotational speed of the shaft?

14)   A 3-phase heater dissipates 15 kW when connected to a 208-V, 3-phase line.
(2)   a)   What is the line current if the resistors are connected in wye?
(2)   b)   What is the line current if the resistors are connected in delta?
(2)   c)   If the resistors are known to be connected in wye, what is the resistance of each?

15) The effective impedances of the main and auxiliary windings of a split-phase motor under locked rotor conditions are:

	Effective Resistance (Ω)	Effective Reactance (Ω)
Main winding	5	10
Auxiliary winding	8	6

If the line voltage is 123 V, calculate

(3) a) the magnitude of the currents in the auxiliary and main windings,
(2) b) the phase angle between the current in the auxiliary winding and the current in the main winding,
(5) c) the line current and
(5) d) the power factor under locked-rotor conditions.

The End

** Merry Christmas **

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